

Wind Erosion in Marginal Mediterranean Dryland Areas, Khanasser Valley- a Case Study

Z. Massri, ICARDA, P.O.Box 5460, Aleppo, Syria (*E-mail: Z.Masri@cgiar.org*)

M. Zöbisch, AIT, P.O.Box 4, K. Luang, Pathumthani, Thai.12120, (*E-mail: zoebisch@ait.ac.th*)

A. Bruggeman, ICARDA, P.O.Box 5460, Aleppo, Syria (*E-mail: A.Bruggeman@cgiar.org*)

P. Hayek, ICARDA, P.O.Box 5460, Aleppo, Syria (*E-mail: P.Hayek@cgiar.org*)

M. Kardous, IRA, Al-Jarf- 4119, Médenine, Tunisia. (*E-mail: mouldi.kardous@ira.rnrt.tn*)

Introduction

Wind erosion in the marginal drylands of the Mediterranean region is a serious problem, through its direct influence on particularly vulnerable land. Drylands are extremely susceptible to wind erosion because soils tend to be dry, poorly structured and sparsely covered by vegetation. Evidence of wind erosion is widespread throughout the dry areas of West Asia and North Africa. A major limitation in these areas is the lack of adequate and reliable rainfall to support a sustainable, protective land cover against the erosive forces of the wind. The replacement of natural, drought-tolerant species with crop cultivation and over-grazing of rangelands by small ruminants, due to growing population pressure and food demand, further exacerbate the problem.

The Khanasser Valley, where this study was conducted, is located at the fringe of the Syrian steppe, 70 km southeast of Aleppo. The Valley lies between the hill ranges of Jebel Al Hass in the west and Jebel Shbeith in the east. The soils in the valley floor are fine and moderately textured dark-brown to brown Calcisols, Gypsisols, Leptisols and Cambisols (Louis Berger International, 1982). The soils of Jebel Al-Hass and Jebel Shbeith plateaus are Inceptisols. Annual rainfall, which occurs during October and May, is normally 200-250 mm. Most households practice a combination of crop production and livestock rearing. Rainfed farming, with barley as the dominant crop, occupies the major part of the arable land. Fields are grazed by sheep after harvesting, leaving a bare disturbed soil surface, with particles loosened by the trampling of the sheep.

The purpose of this study was to quantify fluxes of wind-blown soil particles in the Valley and to assess the factors that affect the wind erosion process.

Material and Methods

During the dry summer months in 1998-2001, fluxes of soil blown particles were measured with BSNE samplers at two locations in the Khanasser Valley. One site was permanently located close to Um-Mial village on the plateau of Jebel Shbeith. This site is sparsely covered with natural vegetation. The other site was located in a rainfed barley field, after harvesting and grazing, each year at a different site in the valley

bottom. Automated climate stations, which recorded hourly wind parameters at 2-m height, were located on the eastern plateau at Um-Mial and in the southern part of the valley bottom in Qurbatieh.

Each field was set up with 17 BSNE sampling clusters, constructed following the design of Fryrear (1986). The clusters were arranged in a radial setup covering the eight main compass directions. Radial distances from the center location are 50 and 100 m. A cluster consists of five samplers, each attached to a pivoting wind vane, mounted at 0.05, 0.1, 0.2, 0.5, and 1.0-m height, measured from the ground to the center of the inlet. The width and height of the sampler inlet areas are 20x10, 20x20, 30x20, 20x50, and 20x50 mm, for the respective heights. The trapped airborne fractions were collected on a weekly basis.

Analogous to Fryrear et al. (1998), a wind factor was computed for hourly wind speeds, assuming a threshold velocity of 5 m/s. The percentage organic matter (*OM*) and water-stable aggregates retained on a 0.5-mm sieve (*WSA*) were measured by standard methods (Ryan et al., 2001) for all five sites. The soil erodible fraction (*EF*), the soil crust factor (*SCF*), soil roughness (*RR*), and soil cover (*SC*) were computed according to procedures presented by Fryrear et al. (1998). The last two factors were visually estimated in the field. A second soil erodibility index (*R*) was calculated as described by Shiyatyy et al. (1972).

Results and Discussion

For each site, the total mass of trapped material was computed for the complete sampling period. The material trapped at the different heights was computed as an average of the 17 samplers. Fryrear and Saleh (1993) use a two-step model with a power function to describe the vertical distribution of suspended materials and an exponential equation to describe the distribution caused by saltation and creep processes. Power functions provided a good fit for the relation between the trapped material and the sampler height for all eight trials. Considering that the bottom of the inlet of the first sampler is located 4 cm above the surface, it is likely that the trapped fractions mainly represent the suspended fraction.

The absolute difference between the total mass for the 5 to 100 cm height integrated by a power function and the mass computed by a stepwise integration averaged 2.5%. For all four seasons, the airborne mass at the Um-Mial the site, located in the degraded natural vegetation of the plateau, was substantially lower than the airborne mass of the harvested and grazed barley fields in the valley floor (Table 1).

Table 1. The soil mass flux at the study sites during four summers (1998-2001).

Site	Year	Samplin g period	Soil mass flux at 5 heights					Total mass flux ¹
			5	10	20	50	100	
			-----	g/cm ²		-----	g/cm width/d	
			----			----		
Um-Mial	1998	84	0.42	0.21	0.11	0.05	0.03	0.084
Qurbatieh	1998	84	0.58	0.36	0.26	0.19	0.16	0.248
Um-Mial	1999	82	0.18	0.07	0.04	0.03	0.04	0.051
Mgherat	1999	90	1.76	0.80	0.49	0.32	0.23	0.424
Um-Mial	2000	90	0.49	0.27	0.22	0.15	0.13	0.183
Serdah	2000	88	0.91	0.44	0.36	0.22	0.21	0.237
Um-Mial	2001	100	0.15	0.07	0.04	0.02	0.02	0.031
Rashadieh	2001	98	0.98	0.61	0.34	0.18	0.15	0.247

¹ Total mass flux per day integrated over the 5 to 100-cm height using a power function.

Average wind speeds for the four observed sampling periods varied between 3.2 and 3.9 m/s in Qurbatieh and 3.7 and 4.8 m/s in Um-Mial. The weekly sampling does not allow the establishment of direct relationships between eroded material and wind parameters, but evidence of the effect of the wind was clear for extreme events. For instance, in Um-Mial 30% of the total soil loss for the 2000 season was trapped during one weekly event. The average wind speed, average daily maximum wind speed, and the wind factor for this week were 31%, 21%, and 76% higher than the average values of these parameters for the complete season.

The airborne soil mass was negatively correlated with the organic matter content (-0.87), water stable aggregates (-0.88), soil cover (-0.76), and soil crust factor (-0.81). Correlations between the erodibility indices and the soil loss were small, 0.30 for *EF* and 0.31 for *R*. It is evident that the improvement of organic matter, soil structure, and soil cover properties can substantially reduce wind erosion.

Airborne fraction quantities decreased with height above the soil surface, while the particle-size distribution became more skewed towards the finer fractions (Fig. 1). Organic matter, available phosphorus, total nitrogen, and exchangeable potassium quantities varied considerably among sites and among heights. The enrichment ratios of organic matter and total nutrients of the trapped material versus the parent soil increased with height above the soil surface. Ratios varied between 0.8 and 3.

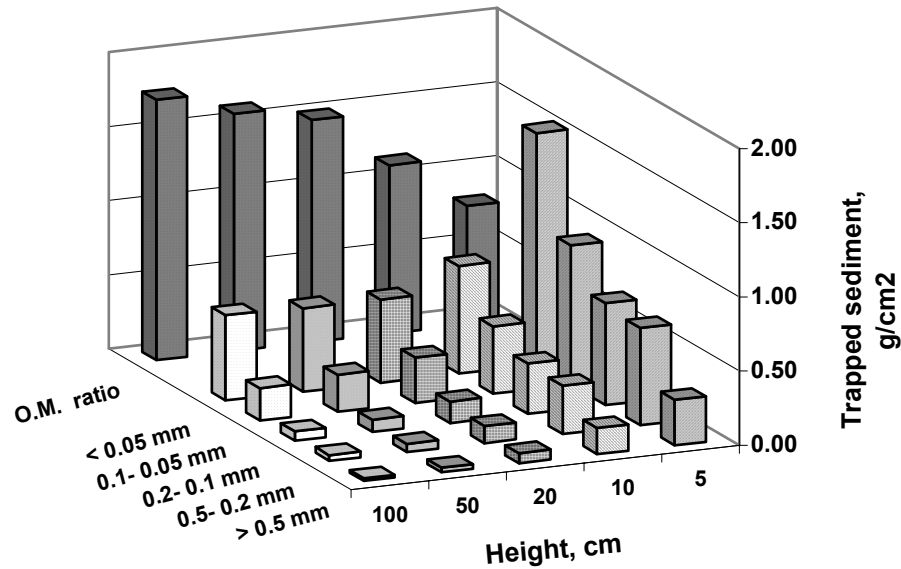


Figure 1. Relation of the particle-size distribution of the trapped airborne materials (g/cm^2) and organic matter enrichment ratio (O.M. ratio) with height for Um-Mial site, 1999.

Conclusions

Results of four seasons of wind erosion research in Khanasser Valley, Syria, indicated that wind erosion is a serious problem in sparsely covered dryland environments. The physically removed wind-blown mass consisted of the lighter soil constituents such as organic matter, clay, and silt. The eroded material had generally higher nutrient contents than the parent soil. Nutrient loss is one of the major wind erosion hazards. Losses of the most fertile part of the soil is reducing the productivity of already poor soils and is threatening the sustainability of the natural resources in the dry areas.

Erosion mass fluxes were substantially higher in the harvested and grazed barley fields of the valley floor than in the degraded natural vegetation on the plateau. The loosely structured soils in the valley floor were more susceptible to wind erosion. Even the sparse natural vegetation and soil cover on the plateau reduced the airborne materials. The relations between eroded soil mass and the wind erosion indices indicated that improved soil and land management can reduce wind erosion. Future research work will focus on the introduction and evaluation of natural resource management practices for reducing the effect of wind erosion in fragile dryland ecosystems.

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